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NASA Contractor Report CR 168123

Documentation of Computer Program GRIDDEL

by K.J. Baumann

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16. Abstract

This report documents GRIDDEL, a computer program which generates finite element meshes for NASTRAN in a manner convenient to the study of laminated composite flat plates. It is capable of creating 8 node HEXA elements, GRID coordinates, and PSOLID data in the appropriate NASTRAN format. It is more convenient for this purpose than use of NASTRAN's preprocessors.

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ABSTRACT

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SUMMARY

GRIDDEL is a short and simple computer program written specically for convenience in generating finite elements and grid points appropriate for studying laminated composite flat plates on NASTRAN. It relieves the engineer from the tedious and time consuming use of NASTRAN's (for our purpose) akward preprocessors. Grid points are generated in a sequence resulting in minimal bandwidth for common laminate geometries. Eight node HEXA elements, GRID coordinates, and PSOLID data are generated in formats appropriate for NASTRAN input. A minimal amount of input is required, and the origin of grid coordinates may be arbitrarily specified.

INTRODUCTION

Although NASTRAN features preprocessors capable of generating elements and meshes, they are found to be very akward for studying laminated composite flat plates. GRIDDEL is written and documented since it may be of more general use in studies of laminated plates.

The desire to model Graphite/Epoxy plates of varying thicknesses, stacking sequences, lengths, widths, material properties, and mesh sizes led to this programs's development. Far less input is required using GRIDDEL than would be using NASTRAN's preprocessors. For example, a 3D mesh of thousands of elements and grid points can be generated in a few minutes.

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CAPABILITIES

1) Generates 3D mesh of 8 node brick elements, grid points, and PSOLID data (CHEXA, GRID, and PSOLID NASTRAN data in NASTRAN input format).
2) Lamina material ids can be specified layer by layer in the z-direction.
3) Easy to change one or more lamina thickness, material id, length, width, mesh size.
4) Arbitrary origin coordinates.
5) Bandwidth is minimal for typical laminates being studied.
6) Variable element sizes easy to input.

LIMITATIONS

1) Presently capable only of 8 node brick elements.
2) Input appropriate for NASTRAN KCS version.
3) Size of mesh limited by dimension statements; currently 20 x 10 x 33 = 6600 elements in x,y,z directions.
4) Generates grid points and elements only in z,y,x sequence.
5) Elements (lamina) with the same PSOLID cards lie in xy planes.

TITLE

GRIDDEL INPUT

PROJECT NUMBER

ANALYST

SHEET ___ OF ___

STATEMENT NUMBER

IDENTIFICATION

FORTRAN STATEMENT

YSTPT ZSTPT

Comment: X, Y, Z coords of grid pt. number 1

number of elements in x, y and z directions

number of nodes in x, y and z directions

spacing between subsequent nodes in x direction

repeat NOELX times

spacing between " " " Y "

repeat NOELY times

spacing between " " " Z "

repeat NOELZ times

must be 321 currently

MID of each successive layer in Z direction

repeat NOELZ times

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FORM 0 (Rev. 9-76)

SAMPLE PROBLEM 1 (simple test case)

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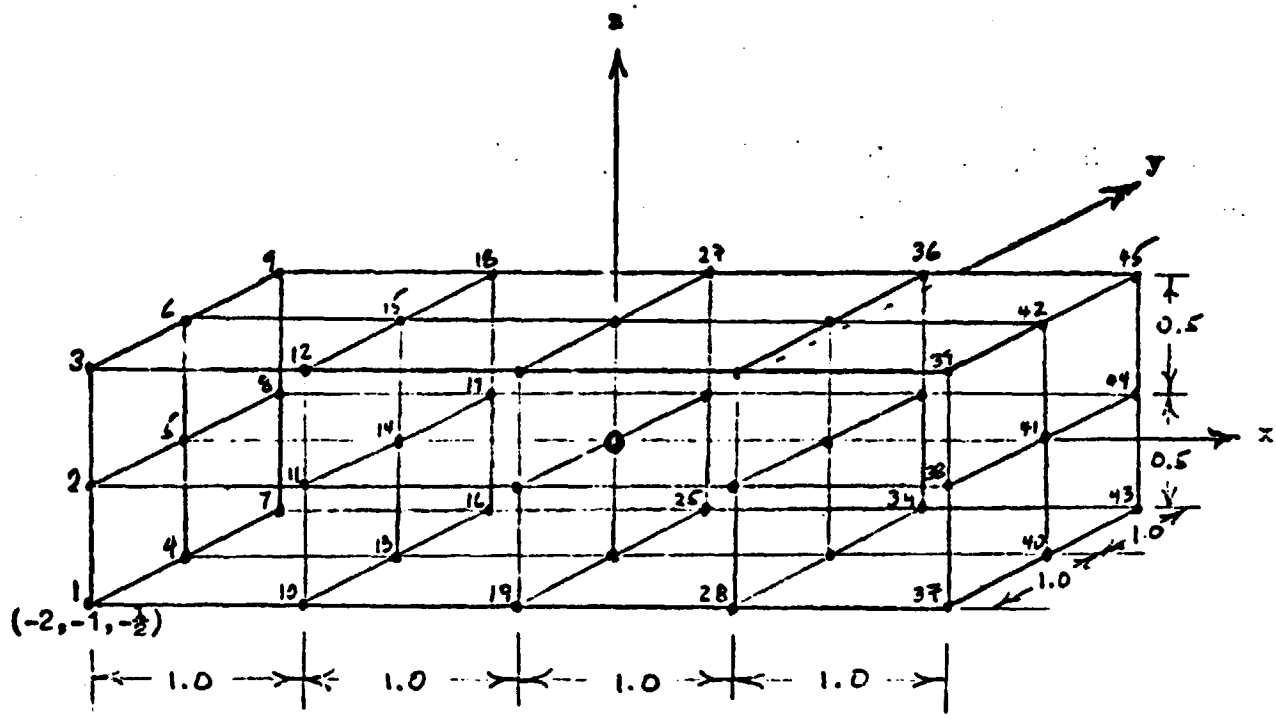

	x	y	z
Origin coordinates	-2.0	-1.0	-0.5
Number of nodes	5	3	3
Number of elements	4	2	2
Node spacing	1.0 1.0 1.0 1.0	1.0 1.0	0.5 0.5

INPUT:

```
-2.0     -1.0     -0.5
  4  2  2
  5  3  3
        1.0
        1.0
        1.0
        1.0
        1.0
        1.0
        0.5
        0.5
321
        1
        1
```

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OUTPUT (simple test case)

```
GRID          1        -2.00000-1.00000-0.50000
GRID          2        -2.00000-1.00000 0.00000
GRID          3        -2.00000-1.00000 0.50000
GRID          4        -2.00000 0.00000-0.50000
GRID          5        -2.00000 0.00000 0.00000
GRID          6        -2.00000 0.00000 0.50000
GRID          7        -2.00000 1.00000-0.50000
GRID          8        -2.00000 1.00000 0.00000
GRID          9        -2.00000 1.00000 0.50000
GRID         10        -1.00000-1.00000-0.50000
GRID         11        -1.00000-1.00000 0.00000
GRID         12        -1.00000-1.00000 0.50000
GRID         13        -1.00000 0.00000-0.50000
GRID         14        -1.00000 0.00000 0.00000
GRID         15        -1.00000 0.00000 0.50000
GRID         16        -1.00000 1.00000-0.50000
GRID         17        -1.00000 1.00000 0.00000
GRID         18        -1.00000 1.00000 0.50000
GRID         19         0.00000-1.00000-0.50000
GRID         20         0.00000-1.00000 0.00000
GRID         21         0.00000-1.00000 0.50000
GRID         22         0.00000 0.00000-0.50000
GRID         23         0.00000 0.00000 0.00000
GRID         24         0.00000 0.00000 0.50000
GRID         25         0.00000 1.00000-0.50000
GRID         26         0.00000 1.00000 0.00000
GRID         27         0.00000 1.00000 0.50000
GRID         28         1.00000-1.00000-0.50000
GRID         29         1.00000-1.00000 0.00000
GRID         30         1.00000-1.00000 0.50000
GRID         31         1.00000 0.00000-0.50000
GRID         32         1.00000 0.00000 0.00000
GRID         33         1.00000 0.00000 0.50000
GRID         34         1.00000 1.00000-0.50000
GRID         35         1.00000 1.00000 0.00000
GRID         36         1.00000 1.00000 0.50000
GRID         37         2.00000-1.00000-0.50000
GRID         38         2.00000-1.00000 0.00000
GRID         39         2.00000-1.00000 0.50000
GRID         40         2.00000 0.00000-0.50000
GRID         41         2.00000 0.00000 0.00000
GRID         42         2.00000 0.00000 0.50000
GRID         43         2.00000 1.00000-0.50000
GRID         44         2.00000 1.00000 0.00000
GRID         45         2.00000 1.00000 0.50000
CHEXA         1      1      1      10     13      4      2     11AC     1
+C     1     14     5
CHEXA         2      2      2      11     14      5      3     12AC     2
+C     2     15     6
CHEXA         3      3      4      13     16      7      5     14AC     3
+C     3     17     8
CHEXA         4      4      5      14     17      8      6     15AC     4
+C     4     18     9
CHEXA         5      5     10      19     22     13     11     20AC     5
+C     5     23    14
CHEXA         6      6     11      20     23     14     12     21AC     6
+C     6     24    15
CHEXA         7      7     13      22     25     16     14     23AC     7
+C     7     26    17
CHEXA         8      8     14      23     26     17     15     24AC     8
+C     8     27    18
CHEXA         9      9     19      28     31     22     20     29AC     9
+C     9     32    23
CHEXA        10     10     20      29     32     23     21     30AC    10
+C    10     33    24
CHEXA        11     11     22      31     34     25     23     32AC    11
+C    11     35    26
CHEXA        12     12     23      32     35     26     24     33AC    12
+C    12     36    27
CHEXA        13     13     [illegible]     [illegible]     [illegible]     31     29     [illegible]     [illegible]
```

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OUTPUT cont'd. (simple test case)

```
+C     13      41      32
CHEXA          14      14      29      38      41      32      30      39AC    14
+C     14      42      33
CHEXA          15      15      31      40      43      34      32      41AC    15
+C     15      44      35
CHEXA          16      16      32      41      44      35      33      42AC    16
+C     16      45      36
PSOLID          1       1
PSOLID          2       1
PSOLID          3       1
PSOLID          4       1
PSOLID          5       1
PSOLID          6       1
PSOLID          7       1
PSOLID          8       1
PSOLID          9       1
PSOLID         10       1
PSOLID         11       1
PSOLID         12       1
PSOLID         13       1
PSOLID         14       1
PSOLID         15       1
PSOLID         16       1
```

SAMPLE PROBLEM 2 (Quasi-isotropic Graphite/Epoxy 16 layer plate)
(stacking sequence $(0/+45/90/-45/-45/90/+45/0)_s$)

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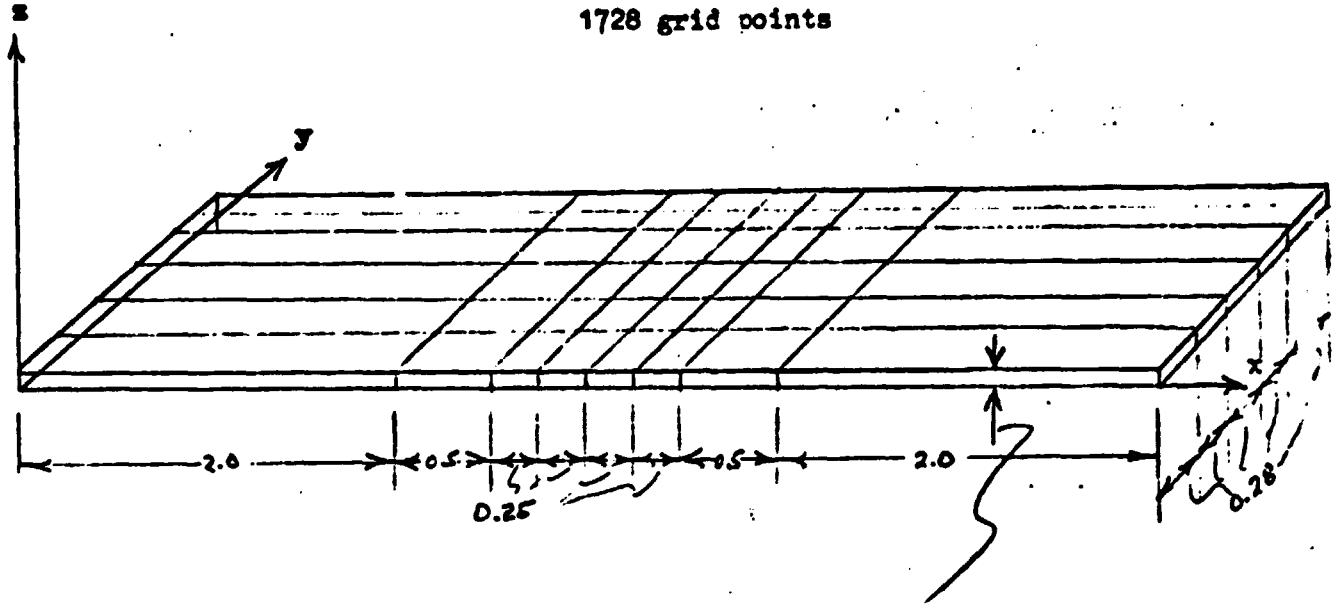
1240 elements
1728 grid points



0.0795 thickness in z-direction
32 nodes, 31 elements in z-direction
(not shown) representing 16 Gr/E plies (each 0.0045)
and 15 Epoxy interplies (each 0.0005)

INPUT:

```
      0.0       0.0       0.0
   8  5 31
   9  6 32
2.0
0.5
0.25
0.25
0.25
0.25
0.5
2.00
0.28
0.28
0.28
0.28
0.28
0.0045
0.0005
0.0045
0.0005
0.0045
0.0005
0.0045
0.0005
0.0045
0.0005
0.0045
0.0005
0.0045
```

INPUT cont'd. (sample problem 2)

```
0.0005
0.0045
0.0005
0.0045
0.0005
0.0045
0.0005
0.0045
0.0005
0.0045
0.0005
0.0045
0.0005
0.0045
0.0005
0.0045
0.0005
0.0045
321
```

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OUTPUT:

Output is not included due to bulkiness of 1728 grid point, 1240 element, and 1240 PSOLID data generated.

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```
0000200 C     THIS PROGRAM GENERATES 3D CARTESIAN GRID POINTS AND ELEMENTS
0000300 C     FOR NASTRAN 8 NODE REGULAR BRICK ELEMENTS
0000400       DIMENSION DELTX(20),DELTY(10),DELTZ(33),LAMMID(33),NODENO(21,11,3-
0000500      C4),X(21,11,34),Y(21,11,34),Z(21,11,34),DX(20),DY(10),DZ(33),IELNO-
0000600      C(21,11,34),IG1(21,11,34),IG2(21,11,34),IG3(21,11,34),IG4(21,11,34-
0000700      C),IG5(21,11,34),IG6(21,11,34),IG7(21,11,34),IG8(21,11,34),IELMID(-
0000726      C21,11,34)
0001000 C     NODENO IS GRID POINT NUMBER
0001100 C     NEXT CARD READS COORDS OF ARBITRARY ORIGIN
0001200       READ(5,10)XSTPT,YSTPT,ZSTPT
0001300    10 FORMAT(3F8.5)
0001400 C     NEXT CARD READS NUMBER OF ELEMENTS IN X,Y,Z DIRECTIONS
0001500       READ(5,20)NOELX,NOELY,NOELZ
0001600    20 FORMAT(3I3)
0001700 C     NEXT CARD READS NUMBER OF NODES IN X,Y,Z DIRECTIONS
0001701       READ(5,25)NONODX,NONODY,NONODZ
0001702    25 FORMAT(3I3)
0001705 C     NEXT GROUP OF CARDS READS NODE SPACINGS IN X,Y,AND Z DIRECTIONS
0001710       DO 30 I=1,NOELX,1
0001715    30 READ(5,40)DELTX(I)
0001720    40 FORMAT(F10.3)
0001740       DO 50 I=1,NOELY
0002060    50 READ(5,40)DELTY(I)
0002080       DO 60 I=1,NOELZ
0002100    60 READ(5,40)DELTZ(I)
0002120 C     ONLY THE OPTION 321=KEYGEN IS CURRENTLY PROGRAMMED
0002140 C     KEYGEN=123 GENERATES NODES IN ORDER X,Y,Z; 213 GIVES Y,X,Z, ETC.
0002160       READ(5,70)KEYGEN
0002180    70 FORMAT(I3)
0002182 C     THE NEXT CARD READS THE MATERIAL I.D. (MID)
0002184 C     OF EACH LAMINA OF ELEMENTS IN THE XY PLANE STARTING AT THE
0002186 C     Z ORIGIN AND PROGRESSING SEQUENTIALLY IN THE +Z DIRECTION
0002188       DO 100 K=1,NOELZ
0002190       READ(5,90)LAMMID(K)
0002192    90 FORMAT(I8)
0002194   100 CONTINUE
0002196 C     THE FOLLOWING GENERATES A LINE OF NONODZ NODE NUMBERS IN THE
0002198 C     Z DIRECTION,THEN REPEATS IT NONODY TIMES IN Y DIRECTION, AND
0002200 C     REPEATS  ALL THAT IN THE Z DIRECTION.  THERE ARE 3 LEFTHAND
0002202 C     (132,213,AND 321) AND 3 RIGHT HAND SYSTEMS (123, 231,
0002204 C     AND 312) WHICH COULD BE PROGRAMMED.
0002206       DO 1000 I=1,NONODX
0002208       DO 1000 J=1,NONODY
0002210       DO 1000 K=1,NONODZ
0002300       NODENO(I,J,K)=NONODZ*(J-1)+K+NONODZ*NONODY*(I-1)
0002400  1000 CONTINUE
0002500 C     THE FOLLOWING GENERATES DISTANCES FROM THE START POINT FOR
0002600 C     EACH NODAL PLANE
0002700       X(1,1,1)=XSTPT
0002800       Y(1,1,1)=YSTPT
0002900       Z(1,1,1)=ZSTPT
0003000       DUMX=0.0
0003100       DUMY=0.0
0003200       DUMZ=0.0
```

```
0003300       DO 4000 I=1,NOELX
0003400       DX(I+1)=DELTX(I)+DUMX
0003500       DUMX=DUMX +DELTX(I)
0003600  4000 CONTINUE
0003700       DO 4010 I=1,NOELY
0003800       DY(I+1)=DELTY(I) + DUMY
0003820       DUMY=DUMY + DELTY(I)
0003900  4010 CONTINUE
0004000       DO 4020 I=1,NOELZ
0004100       DZ(I+1)=DELTZ(I)+DUMZ
0004200       DUMZ= DUMZ+DELTZ(I)
0004300  4020 CONTINUE
0004500 C     THE FOLLOWING GENERATES GRID POINT COORDINATES
0004600       DX(1)=0.0
0004700       DY(1)=0.0
0004800       DZ(1)=0.0
0004900       DO 5000 I=1,NONODX
0005000       DO 4990 J=1,NONODY
0005100       DO 4980 K=1,NONODZ
0005200       X(I,J,K)=X(1,1,1)+DX(I)
0005300       Y(I,J,K)=Y(1,1,1) + DY(J)
0005400       Z(I,J,K)= Z(1,1,1) + DZ(K)
0005500  4980 CONTINUE
0005600  4990 CONTINUE
0005700  5000 CONTINUE
0005800 C     THE PREVIOUS PART OF THE PROGRAM HAS GENERATED GRID POINT
0005900 C     NUMBERS, AND GRID POINT COORDINATES.  THE FOLLOWING WILL
0006000 C     GENERATE ELEMENTS CONNECTING THESE GRID POINTS. ELEMENT
0006100 C     NUMBERS WILL BE GENERATED (ARBITRARILY) USING THE SAME
0006200 C     DIRECTIONALITY SCHEME AS THE GRID POINTS, EVEN THOUGH
0006300 C     BANDWIDTH IS RELATED TO GRID NUMBERING AND NOT ELEMENT NUMBERING.
0006500       DO 6000 I=1,NOELX
0006600       DO 5990 J=1,NOELY
0006700       DO 5980 K=1,NOELZ
0006800       IELNO(I,J,K)=(NOELZ*(J-1))+K+(NOELZ*NOELY*(I-1))
0006900       IG1(I,J,K)=NODENO(I,J,K)
0007000       IG2(I,J,K)=NODENO(I+1,J,K)
0007100       IG3(I,J,K)=NODENO(I+1,J+1,K)
0007200       IG4(I,J,K)=NODENO(I,J+1,K)
0007300       IG5(I,J,K)=NODENO(I,J,K+1)
0007400       IG6(I,J,K)=NODENO(I+1,J,K+1)
0007500       IG7(I,J,K)=NODENO(I+1,J+1,K+1)
0007600       IG8(I,J,K)=NODENO(I,J+1,K+1)
0007700       IELMID(I,J,K)=LAMMID(K)
0007800  5980 CONTINUE
0007900  5990 CONTINUE
0008000  6000 CONTINUE
0008200 C     THE FOLLOWING PRINTS OUT THE DATA READ IN
0008300       WRITE(6,7000)XSTPT,YSTPT,ZSTPT
0008400  7000 FORMAT(' ',3F8.5)
0008500       WRITE(6,7010)NOELX,NOELY,NOELZ
0008600  7010 FORMAT(' ',3I3)
0008700       WRITE(6,7020)NONODX,NONODY,NONODZ
0008800  7020 FORMAT(' ',3I3)
```

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```
0008900       DO 7030 I=1,NOELX
0009000  7030 WRITE(6,7040)DELTX(I)
0009100  7040 FORMAT(' ',F10.5)
0009200       DO 7050 J=1,NOELY
0009300  7050 WRITE(6,7040)DELTY(J)
0009400       DO 7060 K=1,NOELZ
0009500  7060 WRITE(6,7040)DELTZ(K)
0009700       WRITE(6,7070)KEYGEN
0009900  7070 FORMAT(' ',I3)
0009910       DO 7075 I=1,NOELZ
0009920  7075 WRITE(6,7080) LAMMID(I)
0009930  7080 FORMAT(' ',I8)
0009940       WRITE(6,7090)
0009950  7090 FORMAT(' ','END OF INPUT REGURGITATION')
0009951  C    THE FOLLOWING PRINTS THE CALCULATED OUTPUT
0009952       DO 8000 I=1,NONODX
0009953       DO 7995 J=1,NONODY
0009954       DO 7990 K=1,NONODZ
0009955       WRITE(6,7980)NODENO(I,J,K),X(I,J,K),Y(I,J,K),Z(I,J,K)
0009956  7980 FORMAT('GRID',4X,I8,8X,3F8.5)
0009957  7990 CONTINUE
0009958  7995 CONTINUE
0009959  8000 CONTINUE
0009960       DO 8100 I=1,NOELX
0009961       DO 8100 J=1,NOELY
0009962       DO 8100 K=1,NOELZ
0009963       WRITE(6,8050)IELNO(I,J,K),IELNO(I,J,K),IG1(I,J,K),IG2(I,J,K),IG3(-
0010020      CI,J,K),IG4(I,J,K),IG5(I,J,K),IG6(I,J,K),IELNO(I,J,K)
0010040  8050 FORMAT('CHEXA',3X,8I8,'AC',I6)
0010060       WRITE(6,8060)IELNO(I,J,K),IG7(I,J,K),IG8(I,J,K)
0010080  8060 FORMAT('+C',I6,2I8)
0010100  8100 CONTINUE
0010120       DO 8200 I=1,NOELX
0010140       DO 8200 J=1,NOELY
0010160       DO 8200 K=1,NOELZ
0010180       WRITE(6,8150)IELNO(I,J,K),IELMID(I,J,K)
0010200  8150 FORMAT('PSOLID',2X,2I8)
0010220  8200 CONTINUE
0010240       STOP
0010260       END
0010280
```

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